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POWER ANALYSIS OF GRAND VITARA CAR

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APPROVAL

The final project entitles "**Power Analysis of Grand Vitara Car**" has been approved by supervisors and authorized by Secretary of International Program as partial fulfillment of the requirements for getting the Bachelor Degree of Engineering in Automotive Department of Muhammadiyah University of Surakarta.

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POWER ANALYSIS OF GRAND VITARA CAR

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ABSTRACT

The objective of this research is to know the power engine of Grand Vitara Car.Research uses engine 2.0 liters. Use calculation analysis to know that power of Grand Vitara Car.

The first step to start calculate we collects all the data engine of Grand Vitara Car, diameter of bore, length of stroke, volume of cylinder, and fuel used. After all the data has been collected. Then begins the process of calculation fuel combustion, pressure, torque, and power.

The calculation of the engine analysis of crank angle and pressure, that at crank angle 15^o until 180^o, the pressure table show is decreased, the engine analysis of crank angle and force, that at crank angle 15^o until 180^o, the force table show is decreased, the engine analysis of crank angle and torque, that at crank angle 15^o until 30^o, the torque show is increased, and at crank angle 45^o until 180^o, the torque show is decreased.

Key words: pressure, power and torque.

Background of The Study

Car (short of an automobile which comes from the Greek 'autos' (own)) and Latin 'movere' (move) is four or more wheeled vehicle that carries its own engine. Types of cars, including buses, vans, trucks. Operation of the car is called driving. Over time the car needs for humans its increasing because it is very helpful to the process of traveling and working, the development of the car in the country Indonesia is growing very rapidly, especially the use of an SUV. The development of the SUV (Sport Utility Vehicle) in Indonesia will be interesting to observe. Since the start of the type of this car with the toughness, agility and endurance in various fields earned him many fans in the country. Orientation SUV development is focused on its ability to penetrate various field. For that SUVs are often said to be a cruiser car for extensive home range, and the car was often used by many organizations as field operations for multi-functional car. Understanding SUV (Sport Utility Vehicle) is a car designed to carry passengers and goods such as cars pick up. This car can usually equipped with 4-wheel drive system (4 x 4) and also comes with a small tub open the taillights. This car is also

designed to be able to pass through terrain both on road and off road. However, recently classified SUV car does not have to have a 4 wheel drive system or pickup. The car has a powerful engine, great body which can accommodate passengers and freight, and able to be used both on-road and off-road can be classified as an SUV. SUVs generally divided into 3 categories based on size (size), which also determines the size difference in the car, engine power, passenger room and price.

a. Compact, often also referred to as a mini SUV
   Compact SUV: SUV is a car that has the smallest size class with the ability to carry passengers and goods are limited and have little capacity to saving engine fuel consumption. Length of the car between 4:25 - 4.60 meters. Cars belonging to the compact SUV include: Ford Escape, Audi Q5, Jeep Compass, Range Rover Evoque, Toyota Rav4, Toyota Fortuner, Grand Vitara and Honda CR-V.
b. Mid-Size
   Midsize SUV: is the middle class of SUV. But there are some countries that call this car with car Full Size SUV. Cars that belong to this group are the Hyundai Santa Fe, Land Rover Discovery, Toyota Highlander, Kia Sorento
c. Full-Size
   Full Size SUV: SUV is a car with a large size and represent all the properties of the SUV is equipped with a large, large size, capable of carrying passengers and goods in large quantities, and is able to traverse both onroad and offroad terrain. Cars that fall into this class of car is the Toyota Landcruiser, Toyota Sequoia, Ford Expedition, Mercedes Benz GL.

Objectives of the Study

According to the problems statement above, the research has some objectives of the study. The objective is to analysis engine power.

a. To know the engine power.
b. To know the engine torque.

Benefit of The study

Two benefits of this project study are as follows:

a. Theoretical Benefit

The study is expected to give extra lessons to know about engine Performance.

b. Practical Benefit

The study is expected to learn more the knowledge of researcher and reader about principles mechanisms machine.

Problem Limitations

Problem limitation on the engine test is used In-Line 4-Cylinder 16- Valve DOHC VVT. The fuel which is used in the experiment is gasoline with the number octane of 98. The discussion is about the engine torque and engine. The tools which available and also for issues to be discussed or analyzed is not too widespread. The dynamometer used to know

the power and torque from the engine.

Fundamental Theory
Combustion

Combustion engine is one of the activator engines that utilize heat energy from combustion process becoming mechanic energy in the combustion chamber.

A chemical reaction during which a fuel is oxidized and a large quantity is released is called combustion. Combustion is initiated with a spark plug that ignites the air-fuel mixture in the immediate vicinity of the spark plug electrodes. There is essentially no pressure rise or work done at first, and 5-10% of the air-fuel mixture is consumed

Before the combustion process is fully developed.

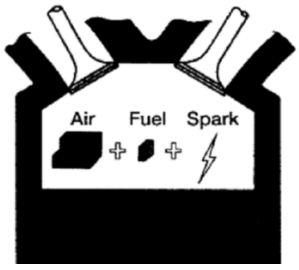

Figure1 Components of Basic Combustion

Actually, the compositions of fuel substances are carbon, hydrocarbon, nitrogen, sulfur, oxygen, ash, and moisture. The reaction in the combustion chamber between air and fuel can be written as:

$C_8H_{18} + 12.5\ (O_2 + 3.76\ N_2) \rightarrow 8\ CO_2 + 9\ H_2O + 47\ N_2 + Energy$
(Pulkrabek Willard W,2001)

Petrol (Premium)

Premium gasoline is derived from a fraction of a given petroleum refining additives or additives, that is Tetra Ethyl Lead (TEL).Premium has the empirical formula Ethyl Benzene (C_8H_{18}). Premium fuel typesdisilat is yellow due to the extra dye.The use of premium is generally used to fuel gasoline-powered motor vehicles, such as cars, motorcycles, etc. The fuel is also often called motor gasoline or petrol with octane number is 88, and has a boiling point of 30^0C-200^0C.

Table 3.2 Gasoline Properties

Fuel Type	*'Premium' Gasoline*
Molecular formula	*C_8H_{18}*
Solubility in water	*Float*
Flash point	*-43 °C*
Auto ignition	*246 °C*
Density g/cm^3 (60 °C)	*0.7321*
Appearance	*Golden*
Octane Research Number	*88*
Energy Content	*44.4 MJ/kg 34.8 MJ/L*

(Source: Laboratory of Oil Technology, Chemical Engineering, Gajahmada State University)

Four-Stroke Engine Work

a. Intake Stroke

The piston descends from the top of the cylinder to the bottom of the cylinder, reducing the pressure inside the cylinder. A mixture of fuel and air, or just air in a diesel engine, is forced by atmospheric (or greater) pressure into the cylinder through the intake port. The intake valve(s) then close. The volume of air/fuel mixture that is drawn into the cylinder, relative to the volume of the cylinder is called, the volumetric efficiency of the engine.

b. Compression Stroke

With both intake and exhaust valves closed, the piston returns to the top of the cylinder compressing the air, or fuel-air mixture into the combustion chamber of the cylinder head.

c. Expansion Stroke

This is the start of the second revolution of the engine. While the piston is close to Top Dead Center, the compressed air–fuel mixture in a gasoline engine is ignited, usually by a spark plug, or fuel is injected into the diesel engine, which ignites due to the heat generated in the air during the compression stroke. The resulting massive pressure from the combustion of the compressed fuel-air mixture forces the piston back down toward bottom dead centre.

d. Exhaust Stroke

During the exhaust stroke, the piston once again returns to top dead center while the exhaust valve is open. This action evacuates the burnt products of combustion from the cylinder by expelling the spent fuel air mixture out through the exhaust valve(s).

ANALYSIS

Force

When the inertia forces are considered in the analysis of the mechanism, the analysis is known as dynamic force analysis, the analysis of force for one cylinder as follow.

$$F_p = P_{mep} . A$$

Where :

F_p = Force (N)

P_{mep} = Mean effective pressure (kPa)

A = Area of piston (m^2)

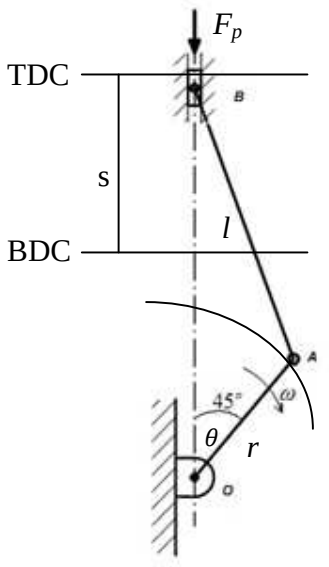

Figure 2 Model of vertical cylinder

where :

l = *Stroke*

r = *radius of crank*

Radius of crank, $r = \frac{1}{2}$ stroke

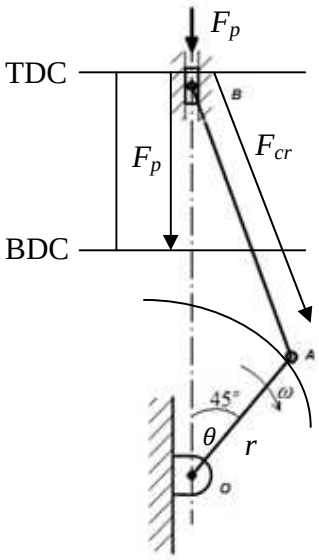

Figure 3 Model of vertical cylinder

Force connecting road,

$F_{cr} = F_p \cdot \sin\theta$

Torque (*T*)

The analysis of torque in the experiment is observed by using the data that obtained with calculation analysis. The analysis of torque for one cylinder as follow.

$T = F.l$

Where :

F = force (N)

l = lever length (m)

T = Torque (Nm)

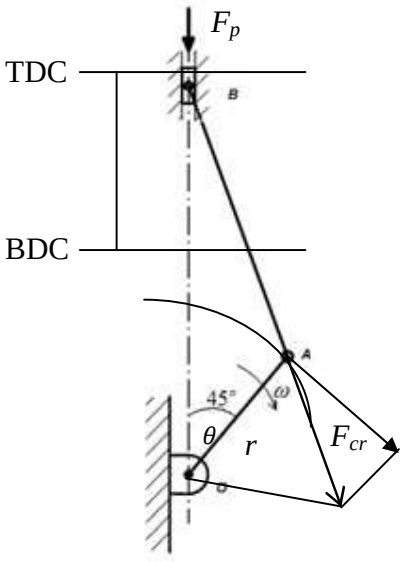

Figure 4 Model of vertical cylinder

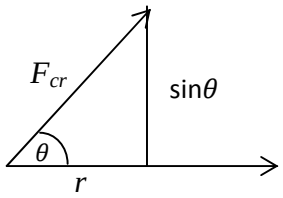

Figure 5 Model of horizontal

$T = F.l$

$= F_{cr}.r \sin\theta$

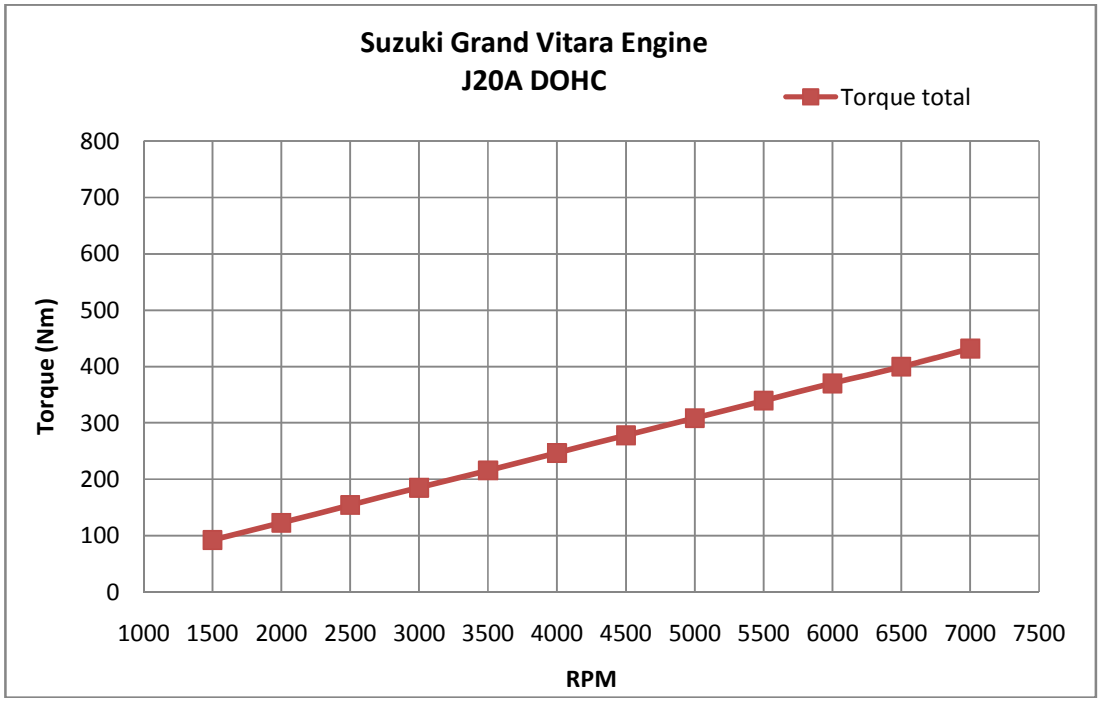

Figure 4 Graphic analysis of torque

From the figure 4, analysis of torque engine shows, that at rotation 1500 rpm, the highest torque generated 92 Nm. On rotation 7000 rpm, the highest torque generated 432 Nm. From the figure 4 can be explained if the value of rpm increase value of torque also increase. The highest torque total from the figure 4 at rpm 7000 is 432 Nm and on spesification the highest torque at rpm 4000 is 183 Nm, this difference is caused the value of mean effective pressure in the engine is constan.

Power

Power is work done that produced by the engine in the experiment, which can be formulated as bellow: (John B, 1988)

$$P = \frac{2.\pi.n.T}{6000}$$

where:

P = Power (kW)

n = Engine rotation(rpm)

T = Torque (Nm)

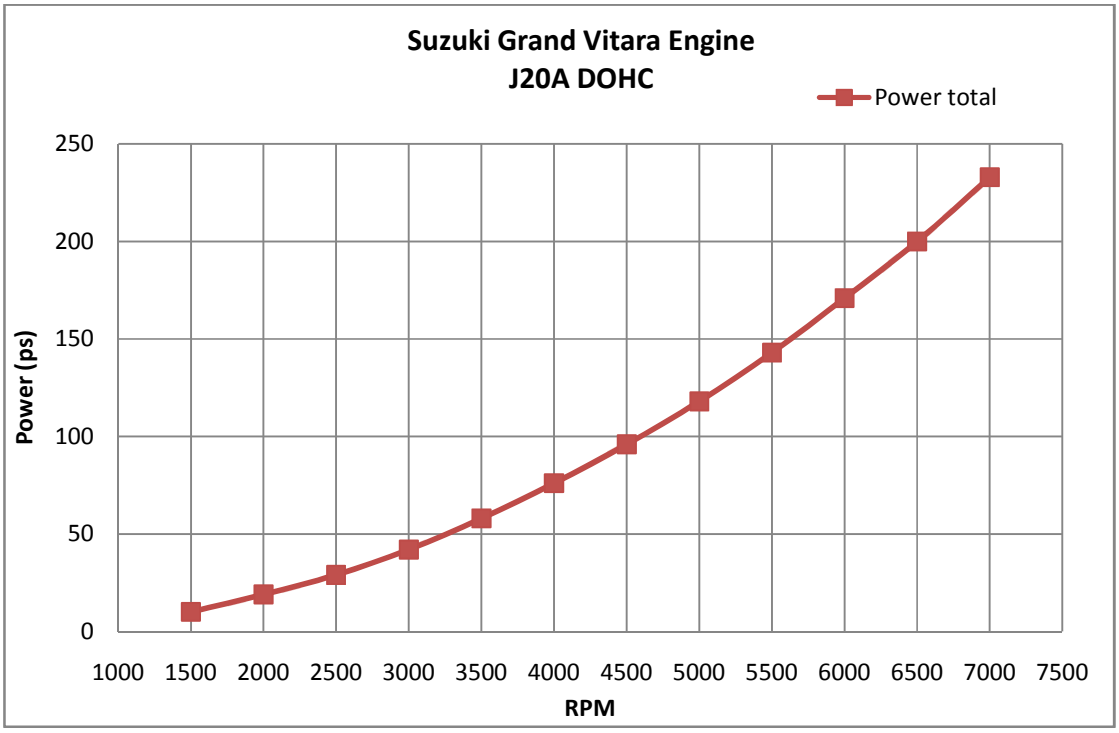

Figure 5 Graphic analysis of power

From the figure 5, analysis of power engine shows, that at rotation 1500 rpm, the highest power generated 10 ps. On rotation 7000 rpm, the highest power generated 233 ps. From the figure 5 can be explained if the value of rpm increase value of power also increase. The highest power total from the figure 5 at rpm 7000 is 233 ps and power on spesification at rpm 6000 is 144 ps. This difference is caused the value of mean effective pressure in the engine is constan.

Conclusion

Based on data analysis from the researchs, The conclusions that can be drawn from the experiment are:

a. That at rotation 1500 rpm, the highest torque generated 92 Nm. On rotation 7000 rpm, the highest torque generated 432 Nm. Torque will increase if the value of rpm increase.
b. That at rotation 1500 rpm, the highest power generated 10 ps. On rotation 7000 rpm, the highest power generated 233 ps. Power will increase if the value of rpm increase.
c. Power total analysis at rpm 6000 is 171 ps and power on spesification is 144 ps, this difference is caused by friction in the engine.
d. Torque total analysis at rpm 4000 is 246 Nm and torque on spesification is 183 Nm, this difference is caused by friction in the engine.

Suggestion

From the experiment that has been done by researcher, here researcher want to give some suggestions for the better in next experiment:

a. The engine that used in the research should be in normal condition to get the optimal performance of the engine.
b. We should to have more data engine as possible to begin the analysis.
c. Expected the full control of the supervisor to students, so that students are able to resolve aproblem when to confront the difficulties in the calculation process.

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